Solex Roofing Installation Manual

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Subject to ongoing revision – latest copy available online

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Overview

Solar roofing offers an alternative to solar traditional solar thermal panels or tubes. Its main advantages are those of cost, aesthetics, and the ability to provide larger solar collecting areas on a given roof slope. The efficiency per m^2 is around 80% that of traditional flat panels.

The output of the solar roofing is heated water, which may be used for hot water, space heating, pool heating or any other water heating application.

Operation Summary

A solar fluid circulates through black silicone rubber absorber strips on the roof and is heated by the sun. Solar glazing in the form of glass or plastic slates, tiles or sheets covers and insulates these strips, and forms the roof surface. An insulation layer behind the strips also reduces heat loss.

The rubber will cope with freezing conditions, and in overheat situations the fluid will drop back into a holding tank below. The fluid is circulated by a solar pump/controller unit which transfers the heat through pipes to where it is required.

Roof Orientation and Pitch

- The roof to be covered should ideally face south.
- Orientations from SE to SW are fine with performance around -12% at the extremes.
- Orientations as far as E or W still perform okay, with performance at around -25%.

Given the choice, and all other considerations being equal, W or SW should be chosen over E or SE, as ambient temperatures are higher in the afternoon increasing performance, and also hot water and heating demand is usually higher in the evening.

The ideal pitch is 30^o to 50^o for year round performance. Steeper pitches up to 60^o favour winter performance which is important for space heating. The slates have a minimum pitch of 25^o and a maximum of 90^o. For pitches under 25^o or over 70^o contact us for additional installation instructions.

Performance

The average annual output (south facing, 30^o-50^o) is in the range 400 - 425kwh/m^2/annum when used to provide hot water, and somewhat more than this when used to provide lower temperature output e.g. for space and pool heating. Instantaneous output under full sun is up to 720w/m^2.

Use the spreadsheet at www.solexenergy.co.uk to calculate roof outputs, energy savings and system costs.

System Sizing

- **Hot water systems** – the recommended sizing is 2m^2 solar roof/person, with a minimum size of 6m^2. The recommended sizing is generally:
  Typical 3 bedroom house – 8m^2
  Typical 4 bedroom house – 10m^2
  Typical 5 bedroom house – 12m^2

- **Space heating systems** – with underfloor heating the recommended minimum size is at least half the floor area in solar roofing, although ideally the solar roof will be at least equal in area to the heated floor area.

- **Pool heating systems** – the recommended size is 60% of the pool area in solar roofing for outdoor pools, and 85% of the pool area for indoor pools (on the assumption that indoor pools are used all year.)

- **Combined systems** – the recommended size is generally the larger of any of the individual parts of the system. E.g. for water and space heating systems, the system is sized to the space heating requirements.

Design and Layout

Solar roofing may be installed

- To the extremities of the roof, or
- As a patch surrounded by a compatible roofing material, or
- As a strip between other non compatible roofing materials.

The visual effect of the solar roofing is a combination of the reflection from the surface, and the black colour of the absorbers beneath. Overall a uniform medium to light grey is observed which changes depending on weather conditions.

Planning Permission (UK)

1. **Retrofit to dwelling house** – applies to:

   - All buildings except I, II* and II listed buildings,
   - All areas except some conservation areas where specific permitted development rights have been removed by the LPA,

   Installing solar roofing is considered permitted development and so does not require planning permission – GPDO, Schedule2, Part1, Class C

2. **Retrofit to dwelling house** – applies to:
   - All buildings except I, II* and II listed buildings,
   - Conservation areas where specific permitted development rights have been removed by the LPA under GPDO Section 4.2

   Installing solar roofing is permitted unless it is to a roof slope which fronts a highway, waterway or open space (‘*relevant location*’). – GPDO Section 4.2

3. **Listed buildings**
   Apply for listed building consent, and planning permission if situation 2 above applies and the roof fronts a relevant location.

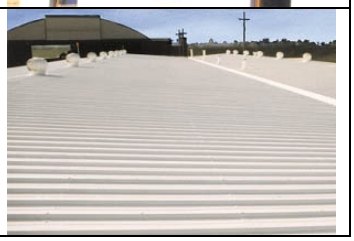
4. **New build houses / extensions**
   Submit details of the solar roofing materials with the planning application. Bring the above permitted development rights to the attention of the LPA if they are minded not to approve this type of material.

5. **Agricultural and forestry buildings**
   Installing solar roofing is considered permitted development and so does not require planning permission – GPDO, Schedule2, Parts 6 & 7

6. **Industrial and warehouse buildings**
   Installing solar roofing is considered permitted development and so does not require planning permission – GPDO, Schedule2, Part 8

Choice of products

We make a range of different types of solar roofing to suit various applications:

Solar Slates These are glass traditional style double lap solar slates, which are compatible with traditional 500 and 600mm (20" and 24") size slates. They are installed onto a normal felted and battened roof structure.	
Nu-lok Slates These are glass single lap slates with a unique easy to fit metal battening system. The glass slates are compatible with Nu-Lok heavy-duty ceramic and natural slates, and also with PV slates. This is an easy to fit, low labour requirement system.	
Solar Tiles These polycarbonate single lap tiles are compatible with Marley Modern/Redland Mini-stonewold concrete tiles. They are ideal for fitting into an existing concrete tiled roof.	
Solar Cladding This is a lightweight solar cladding system for use over existing profile metal roofing. Ideal for industrial applications, it utilises existing profile roof insulation for low imposed weight, low cost, high output systems.	

Installation Skills

The system may be fitted by M&E contractors and roofers working together

- Generally an M&E qualified person should oversee the whole installation
- The battens, insulation, rubber absorber, EPDM membrane may be installed by roofers, under the guidance of M&E
- The manifolds, supply pipes, roof sensor and joints in the absorber by M&E
- Installation of the tiles/slates by the roofers
- Installation of the internal system components by M&E
- Electrical installation of the controller, pump and motorised valves (where applicable) by M&E / qualified electrician

Tools

Required in addition to normal roofing tools:

- Scissors for cutting the absorber strip (not a knife)
- Staple gun / hand tacker for fixing the absorber strip and EPDM
- Crimping pliers (supplied) for the absorber pipe clips
- Silicone oil (supplied) for lubricating absorber joiners and manifolds
- First fix type nail gun and hardened nails (Nu-lok systems only)
- Cordless driver and Pozidrive bits for slate clip screws (solar slate systems only)
- Pump / compressor and fittings for pressure testing

Materials – Calculating Quantities

Quantities may be worked out manually, or calculated using our roof calculator spreadsheet at www.solexenergy.co.uk. This program also outputs a **roof specification** page which may be useful for the roofers as it summarises key dimensions and figures.

Materials – Delivery and Storage

Solar roof materials and components are usually delivered on a pallet. Provisions must be made for handling this on-site. The delivery driver may have tail lift (if requested) and pallet truck, so the pallet may be moved as far as the concrete or tarmac surface will allow.

A delivery note will be included with the consignment, and the materials should be checked against this as soon as practical, and in any event within 2 working days of delivery. Any shortages or damage must be notified within 2 working days of delivery.

Thermal stores are either delivered from stock via a pallet carrier, or direct from the manufacturer. When delivered direct from the manufacturer, the lorry will have no offloading facilities unless requested, and the store must either be forklifted off, or craned off. There is a lifting eye provided in the packaging, which screws into the central top port. When on a level surface stores may be easily moved with a pallet truck. The label on thermal stores must be checked on delivery, to ensure that the correct model has been supplied.

Solar roof components should be protected from the weather before installation. If packets of solar slates become wet the packaging will disintegrate, with the possibility of resulting damage and health and safety issues from falling slates when being handled. Packets or loose stacks of solar slates which become wet will draw in water causing them to stick together. They may be parted using the end of a slate clip or any similar flat object which does not damage the slate edge.

Wetting of the insulation should be avoided if possible, although it will not be damaged by wetting. If exposed to the weather on the roof before slating, most water will drain out down the membrane, and the remainder will evaporate when the roof is watertight.

Sitework – Information for Site Foreman / Main Contractors

Some of the key points regarding the installation:

- The solar roof requires both vertical counterbattens, and horizontal battens (25 x 50)
- The vertical counterbattens must be laid over the breather membrane
- Insulation is laid between the counterbattens before nailing the horizontal battens
- Special attention must be paid to the eaves detail where the solar slates start at the eaves – see relevant diagram
- Solex or our contractors do not supply batten – this must be provided on-site
- When Solex or our contractors arrive on-site we expect the roof to be complete to the membrane and counterbatten stage (i.e. watertight)
- Absorbers must be pressure tested with air before and during fitting the slates/tiles
- Ridges and hips may be wet or dry fitted against the solar slates, and are usually installed when finishing the conventional roofing, after the solar roof has been finished
- Mortared ridges/hips sometimes leach lime or salts which stain the glass. This may be removed with dilute hydrochloric acid, although it will weather off within 6 months
- The system requires pipes (generally 2x 22mm for systems <70m^2) and a cable (generally 1x 2 core) running to the roof
- The system requires a vented expansion tank (supplied by Solex) located at least 500mm below the level of the bottom of the solar roof, and not more than 4m from the top of the solar roof. Brackets are available for wall mounting.
- Sizing is usually as follows:

Roof area	L	W	H	Kg
up to 8m^2	350	270	370	35
up to 25m^2	600	300	450	80
up to 40m^2	1100	290	460	135
up to 70m^2	1100	290	620	185
up to 85m^2	920	420	630	220
up to 115m^2	1100	320	825	265
up to 200m^2	1250	360	1010	420

- The expansion tank requires a cold fill supply, an overflow and must be accessible for maintenance
- Thermal stores, where supplied, are generally large, so provisions must be made for handling (see delivery information above)
- Consideration must be given to access arrangements for thermal stores, and weight loadings of floors (they stand on three metal feet). See the thermal store specifications toward end of this guide.
- Thermal stores (1.5 bar) require a feed & expansion tank (not supplied by Solex). 3.0 bar stores may also be installed as a pressurised system subject to meeting regulations.

Health and Safety Considerations

These are given in addition to all other health and safety guidelines and regulations relevant to roofing, plumbing and general site work, which the tradesmen involved should already be aware of.

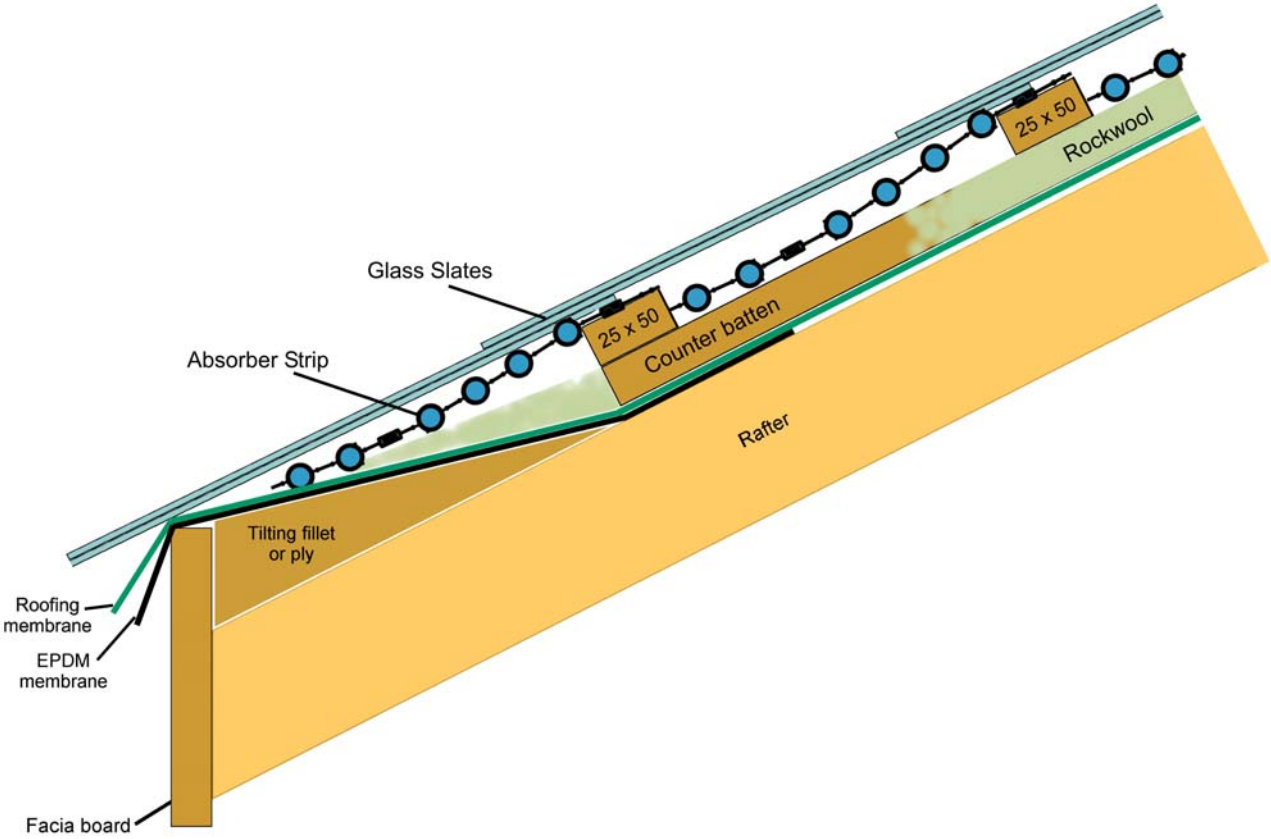
- Boxes of glass slates are heavy, ranging in weight up to 40kg per pack. Suitable handling practices should be adopted. If possible they should be lifted to the scaffold with a forklift.
- Slate boxes which have become wet may disintegrate leading to the possibility of sliding and/or falling slates
- Where glass slates are being handled there is the possibility of breakage, resulting in numerous small glass fragments. If this happens gloves must be worn during cleaning up, which is best done using a dustpan and brush.
- When stacking loose slates vertically against an object, e.g. scaffolding, the edge of the first one should be protected with something soft.
- When stacking loose slates horizontally ensure that no dirt or fragments are trapped between sheets which may cause damage. Slates stacked loose horizontally are liable to slide sideways off the stack without warning, causing damage and hazards.
- Rubber absorber strips are supplied on large rolls which may weigh over 25kg. Suitable handling practices should be adopted.
- Legionella – water stored in hot water cylinders between 20^{o}C and 45^{o}C may breed legionella bacteria. Provision must be made to prevent this, for example by heating the entire cylinder to above 60^{o}C at least once a week.

Vermin

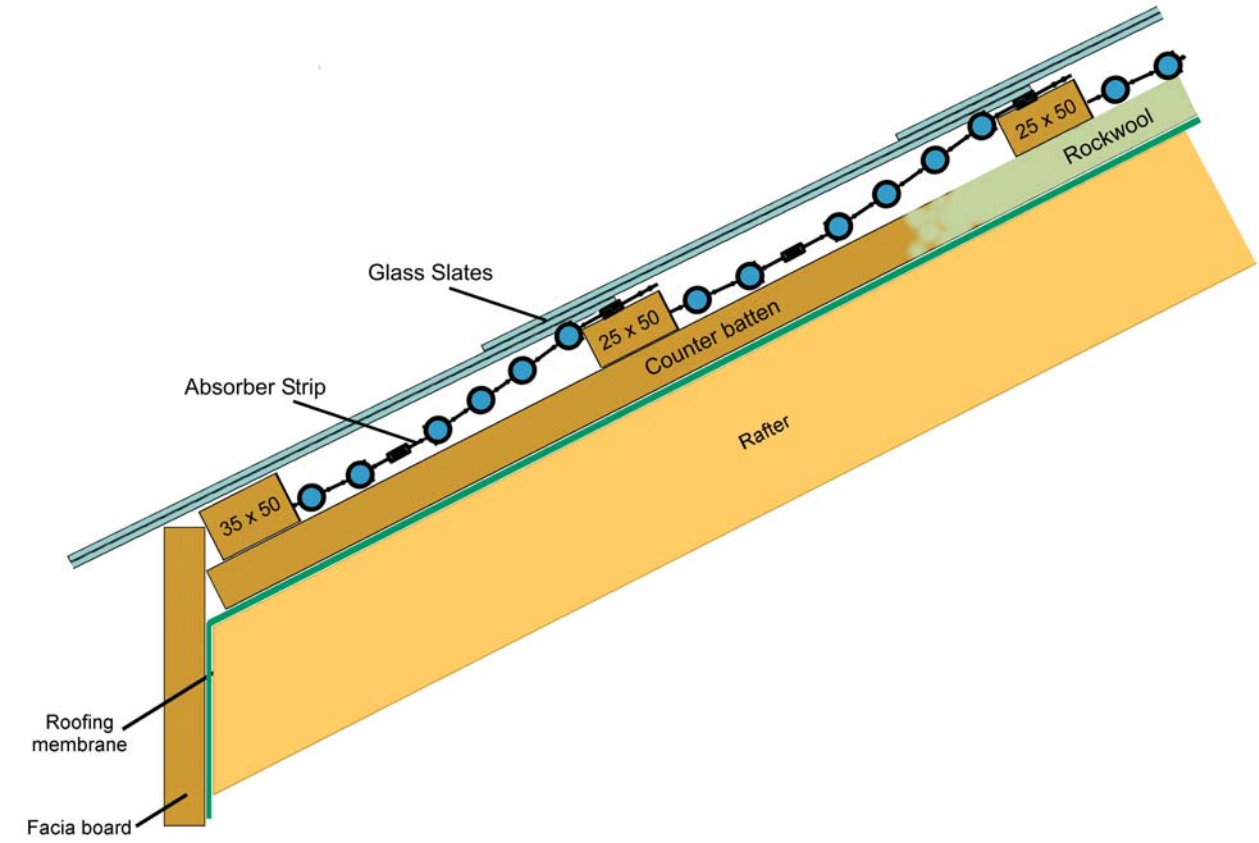
The silicone absorber strip and supply pipes are susceptible to attack by vermin. Adequate precautions should be taken to ensure vermin, especially mice, are not able to access the roof between the breather membrane and slates/tiles.

Roof Installation – Solar slates

The roof takes up a thickness of approx 70mm from the membrane upwards. The roof loading at 34kg/m^2 is similar to that for natural or artificial slates. The construction employed is conventional counterbattens and battens:



Alternative eaves arrangement:



The roof is built up as follows:

1. **Rafters** – for complete eaves to ridge installation of solar slates the rafters should be of length (c x g)+50-f where c = number of courses, g = batten gauge between centres, and f = facia board thickness

2. **Membrane** – a breather membrane should be used, laid across any of the following roof constructions:
   - Rafters, or
   - Rafters with insulation between, or
   - Insulation sarking boards, or
   - Timber sarking boards.

   The breather membrane MUST be laid correctly to form a waterproof layer which will drain water to the eaves without pooling. **In the event of any damage occurring to the absorber at any time, this breather membrane will ensure that no water enters the building.**

3. **Facia and eaves** – where the solar slates go right to the eaves one of the arrangements shown in the diagrams above should be suitable. A tilting fillet or ply may be used, but plastic eaves carriers will melt in the heat under the glass tiles. The membrane can also be dressed down behind the facia, although care must be taken over the fate of water running behind the facia. (picture – eaves before installation of facia)

4. **Counterbattens** – 25mm thick counterbattens must be used. These must go on top of the membrane, and start from under the second batten as shown above.

5. **Insulation** – 25mm mineral fibre batts are cut to fit snugly between the counterbattens, over the whole roof except the far left and far right ‘channels’ between the counterbattens, which are left open to allow space for the absorber loops, manifolds and pipes.

   The easiest way to cut the batts is to place one against a counterbatten, and cut down with a knife using the opposite counterbatten as a guide. Use a blunt tipped knife to avoid damaging the membrane.

   Wetting of the insulation should be avoided if possible, although it will not be damaged by water. If exposed to the weather most water will drain out down the membrane, and the remainder will evaporate when the roof is watertight.

   Note that the insulation supplied is the minimum recommended for the system. Extra insulation, especially in the form of foam insulation boards over the rafters, will increase the efficiency of the system.

6. **EPDM** – the left and right channels are covered with an EPDM membrane, which is stapled to the counterbattens and dressed neatly into the channel. This has three purposes – it protects the breather membrane from UV, it prevents the colour of the membrane from showing through the slates, and in the unlikely event of a leak from a manifold or pipe it offers added protection to the building. The EPDM must therefore be dressed over the eaves to allow run off.

   The EPDM should also be used to cover any roof membrane, insulation, battens etc. which will show through the glass tiles if left uncovered.

7. **Battens** – 25mm x 50mm battens are used, which should be treated or naturally durable, e.g. western red cedar. The batten spacing can be in the range:
   - 500 series 200 - 212mm between centres
   - 600 series 250 - 262mm between centres

   If the solar slate area starts at the eaves the eaves batten must be 10mm thicker – 35mm. A bigger kick-up is possible up to +25mm, but not recommended (50 or 60mm screws for the slate clips may be required).

   Note that as the glass slates cannot be cut, the battens for the eaves course must be spaced the same as for the subsequent courses. The only exception is where longer eaves clips are used for a larger gutter overhang, when the first two battens may be closer together. The space between the first two battens must be kept clear for the absorber strip. Similarly, the battens should be gauged out so that there is a complete course at the ridge.

   The absorber strips will loop under the battens at the ends, so small sections of batten should be left out to allow this, which may be nailed in after the installation of the absorber. The omitted sections will generally be on every other course, although the route of the absorber should be planned before the battening process and the battens installed to suit.

8. **Absorber strips, supply** – these are supplied on 25m rolls. For longer lengths joiner kits are supplied, consisting of short pipe segments and O clips.

   The roof calculator spreadsheet will output the length of absorber required. Alternatively, it may be necessary to work it out manually – the length of the course where the absorber will lay is measured, and the *loop* factor is added for every end of course – 500 series loop=120mm / 600 series loop=150mm. The usual measuring points are the outer edges of the EPDM covered channels detailed above.

Where the roof is sufficiently large, it is necessary to divide it into parallel absorber circuits, which should be as close to equal lengths as possible. For example a roof of 15 courses may be divided into three courses of 5, or a roof of 12 courses may be divided into circuits of 6, 4, 3 or exceptionally 2 courses depending on the overall length of the roof and therefore the length of absorber strip in each circuit.

The Roof Calculator will give some guidance, although generally we recommend that each circuit does not exceed 40m in length, which equates to around $8m^2$ of 500 series roofing or $10m^2$ of 600 series roofing. There is no minimum length of circuits, although having many smaller circuits will result in more manifolds and connections.

9. **Absorber strips, installation** – when installing the rubber absorber, it is advisable to start at the top of the roof, so that there is less foot traffic on the installed rubber.

Starting at the end where the top manifold is required, the absorber is unrolled along the batten with the flange at the top. The flange is positioned to cover the batten and staple gunned to it at 300mm intervals. Standard staples may be used, as the absorber will be held in place by slate fixings which pierce the flange.

At the end of the course, in the channel where the EPDM has been positioned, the absorber is folded back on itself, still keeping the flange at the top. The individual tubes are then split away from each other so that each tube follows a natural curve down to the second course.

When splitting the tubes apart, great care must be taken not to damage the surface of any of the tubes. A pair of scissors (not a Stanley knife) should be used. The point of the scissors is pushed through all the tear lines of the strip, and the tubes pulled apart in both directions as far as necessary. This should be done with care, as sometimes the split can start to run off toward a tube wall. If this happens, use the scissors again to re-start the tear.

The tubes should be arranged neatly so that there are no kinks which could disrupt the flow of water. The redundant centre and bottom strips may get in the way and can be removed at this point if desired. The top flange should be cut at its midpoint and stapled along the battens, extending if necessary with some spare flange which is supplied.

The absorber is then run out along the next course and fixed as before.

In situations where the roof has already been battened, a problem occurs at the course ends where the absorber has to

loop under the batten. In these cases the choice is to either thread the absorber under the batten, or to cut out a section of batten and re-fix it. If it is chosen to thread the absorber under the batten, then the section of split tubes must be arranged very carefully to prevent any of them kinking or squashing.

If it is necessary to join the strip, the ends are trimmed off square using a pair of scissors, and the 'wings' on the tubes cut back for about 50mm. A little silicone oil is sprayed on both the copper joining tubes and the insides of the manifold tubes. The joining tubes are inserted, and the O clips put on and crimped using the pliers supplied.

10. **Manifolds** – copper manifolds are used to terminate the absorber strips. The manifolds have 22mm open ends for the connection of the flow and return pipes. The manifolds are connected with silicone tubing, and O clips similar to those used on the absorbers. The manifolds are short enough to not be damaged by freezing water. Where any copper components are used on the roof there must be at least 50mm of supply pipe each side of them to allow for ice expansion.

The pipes and manifolds should lie in the EPDM covered channel, under the battens. The top of the inlet manifold or chain of manifolds is capped with a short length of silicone tube and a plug, as is the bottom of the outlet manifold or manifold chain.

Where the roof is sufficiently large to necessitate dividing it into parallel absorber circuits, all the inlet manifolds are piped in line up one side, and the outlets up the same or opposite side (depending on an even or odd number of courses. Sometimes it is necessary to return a pipe from an inlet or outlet across the roof, for instance when dividing a roof of 7 courses into 3 and 4 course circuits. Half manifolds are available for use in special circumstances.

The cold inlet pipe must flow in a generally upwards direction from the pump to the bottom of the lowest inlet manifold. The hot outlet pipe must connect to the top of the highest outlet manifold even if the outlet pipe subsequently runs down the roof. This must be done to ensure an even flow throughout the circuits, and to ensure that air is purged from the top circuits.

The inlet and outlet pipes should be taken into the loft or roof space for connecting onto the normal plumbing pipe used internally, ideally under a lap in the roofing membrane, which may be aided by the use of copper U pieces and elbows (supplied). Where it is not possible to pass the tubes under a lap, any penetration through the membrane should be made waterproof. Silicone rubber may be used and sticks well to the silicone tube, although its adhesion to the particular

membrane being used should be checked.

The ends of the absorber strips are separated into individual tubes, and the wings trimmed off by about 50mm with scissors. Clips are put on the tubes and the tubes are connected to the manifolds using a silicone lubricant and crimp clips as detailed above.

11. **Pressure testing** – the system must be pressure tested with air to 2.0 bar. At this pressure any incorrectly made joints should leak or blow off. The system should be left under pressure during the installation of the slates, so that any absorber damage will immediately become evident. Note, air will diffuse through the silicone absorber, so the pressure will decrease over a period – e.g. overnight the pressure may drop from 2.0 to 1.5 bar.

12. **Sensor** – a roof temperature sensor is used to measure the temperature at the hottest point on the roof. It is fitted beneath the absorber strip, generally at a position at least 1 m from the top outlet manifold, near the centre of the absorber, and not close to any area obscured by conventional slates. It should be positioned so that it will lie between two of the absorber tubes, and not next to any dead area of the strip. The sensor is secured to a counterbatten with a small fencing staple or similar, and covered with some silicone rubber. The absorber strip is laid in position over it so a good thermal and mechanical connection is formed.

The wire is passed through the roofing membrane, ideally at an overlap. This high temperature wire with this sensor is 1.5m long and so will almost certainly need to be lengthened using conventional 0.75mm^2 two core lighting flex and a connector block, which should both be located under the rockwool insulation or away from the absorber area to prevent heat damage. The sensor wires carry low voltage so an electrician is not required.

13. Glass slates

Location	500 series, mm	600 series, mm
Standard	500 x 500	300 x 600
Eaves	500 x 285	300 x 335
Ridge	500 x 285	300 x 335
Verge, odds	250 x 500	450 x 600 holed
Verge, evens	500 x 500 holed	300 x 600
Verge-ridge corner	250 x 285	450 x 335
Verge-eaves corner	250 x 285	450 x 335
Hips	500 x 500 cut corner, 6 sizes	300 x 600 cut corner 6 sizes
Valleys and other cut areas	Polycarbonate 750 x 500	Polycarbonate 600 x 600
Matching slate	375 x 500	-
Horizontal coverage	505	305

The glass solar slates are installed over the absorber strips. When installing the slates care must be taken not to damage the absorbers. The glass slates are toughened and so cannot be cut. The roof calculator at www.solexenergy.co.uk can help with sizing a roof to an exact number of slates. The range of sizes supplied is shown in the table.

In general most normal slating practices are followed when using the solar slates, the main difference being in the method of fixing.

Hook length mm	Batten spacing 500 series	Batten spacing 600 series	Headlap mm
70	218	268	70
75	215	265	75
80	213	263	80
85	210	260	85
90	208	258	90
95	205	255	95
100	203	253	100
105	200	250	105

14. Slates hooks – the slates are fixed to the battens with blackened stainless steel hooks and screws. Use of a lightweight cordless driver here is recommended. Two horizontal lines on the flange of the absorber indicate the correct position for the screws. When screwing in the clips they should be tightened just enough to hold the sides of the slates below, but must not be allowed to stress the glass, which could lead to breakage later. Pushing gently on the glass slate below the clip should release the tension.

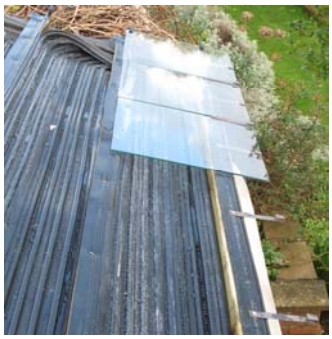
The glass slates should be installed next to each other, with a small gap 1mm between the slates and the screw of the hook

in the row above. If they are pushed up hard to the screws shattered slates can result due to thermal expansion.

The hook length required is related to the batten spacing. Note that the length of a clip is measured from the bottom of the clip to the bottom of the screw hole.

IF A PATCH IS BEING INSTALLED PLEASE JUMP TO 21

15. **Eaves** – slating is started at the eaves, from a verge if present, with a line of the clips screwed to the first batten at the slate width interval, and a line of eaves slates hung on these. A row of clips are then screwed to the first batten between these eaves slates and the first row of standard slates hung.



½ size eaves slates (500 series, 250x285mm) and 1½ size eaves slates (600 series, 450x335mm) are available.

The eaves will overhang the first batten by the clip length minus 25mm. Where this overhang is too small, longer clips may be used if available, although then the batten spacing on the first course may need to be reduced.

16. **Verge** – If the roof runs from one verge to another it is an advantage to design the roof to fit an exact number of slates, to the nearest half slate, using the slating interval given. The slates should overhang the verge wall by around 50-75mm, taking account of whether a bargeboard will be used. The verge can be finished using an undercloak of conventional slates in the normal manner or a dry fix verge can be installed. Alternatively, depending on local regulations, the edges of the slates can be left as they are with just some cement or a bargeboard to fill the gap above the wall top.

Unless secured with a dry fix verge, the edges of the verge slates must be secured to the battens with verge clips (supplied). These are screwed to the lower edge of the battens so that each secures three layers of slates, and the end should be bent in slightly so that it grips the slates. These clips may be installed before slating commences, using a line to get a neat edge.

The first full height verge slate from the eaves will be a 250 x 500 slate (500 series) or a 450 x 600 holed slate (600 series). The 250 wide slate will require a clip modified to go around the thickness of both the eaves and verge slates – this is easily achieved with a pair of pliers. The 450 wide slate-and-a-half has a hole for the clip in the row above. This must be positioned correctly, and with the clip screwed through the lower hole where possible.

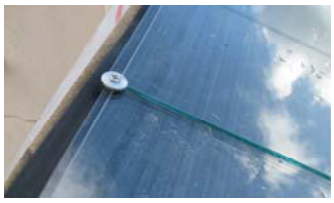
If running out to a second verge, which does not fit to the

nearest ½ slate, polycarbonate slates will need to be cut to fit.

17. **Abutments** – these are slated in the same manner as verges, but omitting the verge clips unless there is a gap for a lead valley etc. Lead soakers are used in the usual manner.

18. **Ridge** – the battens should be gauged out so that a full course is present at the ridge. The ridge slates are hung on slate hooks which where possible are 15mm shorter than standard. A screw and plastic retaining ring screwed between the slates and into the top batten prevents sideways slippage, and secures the slates until the ridge tiles are fitted.

    A verge-to-ridge corner, depending on whether it is on an odd or even course, may require a ½ verge-eaves/ridge slate (500 series, 250x285mm) or a 1½ verge-eaves/ridge slate (600 series, 450x335mm).



19. **Hip** – a range of cut corner slates are available to use at a hip. They fit in many places, but not all, so some polycarbonate slates will be required as well. Generally we recommend 70% cut corner slates (mixed) and 40% polycarbonate slates (10% leeway on quantity). A normal cemented or dry fix ridge can be used over the glass solar slates.
20. **Valley** – polycarbonate slates are used up the edge of a valley.

21. **Polycarbonate slates** – these are easily cut with a jigsaw or handsaw over the edge of something solid – e.g. using the gap between two scaffold boards. They may be fixed using standard slate clips, and/or drilled and screwed. When drilling take account of where the holes will fall in relation to the weather lapping of other slates around it.

    IF A WHOLE ROOF IS BEING INSTALLED SKIP 21 AND 22

22. **Slating a patch** – a patch of solar slates may be installed surrounded by compatible natural or artificial slates. These conventional slates must be 250 x 500 to match the 500 series solar slates, or 300 x 600 to match the 600 series. Note, there will be one more course of glass slates than there are courses of absorbers.

    When using 500 series slates, the first row of glass 500 x 500 slates is laid over the first course of absorbers, using a glass 250 x 500 slate if necessary to get the correct width of cover. The second row will then start and finish with a 375 x 500 glass slate, to maintain the correct bond. As long as there is an even number of courses of absorbers there will no problem at the top of the solar area reverting back to the conventional slates – if there is an odd number of courses of absorbers the slate bond will be disrupted.

When using 600 series slates, the glass slates are simply substituted for the conventional slates over the absorber area.

23. **Slating a strip** – when installing the solar slates into a roof covered with an incompatible material – e.g. clay tiles – the easiest method is to install the solar slates as a strip. This method is the most suitable for retrofit situations, as the existing roof can be stripped off from the top down.

    If the conventional tiles or slates are considerably thicker than the solar slates, the solar area will need to be raised. As a counterbatten is required anyway, this may go part of the way to achieving this extra height. Any extra height may be provided by thicker slating battens, or thicker counterbattens with thicker insulation between them. The top of the insulation should still be flush with the tops of the counterbattens.

    At the bottom of the strip a row of glass eaves slates is used, lapping over the other roofing material. Usually a strip of lead flashing 150-200mm wide is required to obtain an adequate overlap. This may be nailed to the first batten, which should be +10mm (max+25mm) thicker to give a slight kick up.

    At the top a row of glass ridge slates is used, again with lead flashing, attached to the batten above, to make the transition back to the incompatible material. Alternatively, if the solar slates go right to the ridge, then finish with ridge tiles as detailed in the whole roof section above.

    At the sides, it is easiest if the strip runs out to hips, valleys and/or verges, where it is finished as detailed above. Alternatively, if the strip meets the incompatible material at one or other side, a decision will need to be taken on-site as to the best interface method, which will usually involve some form of lead flashing.

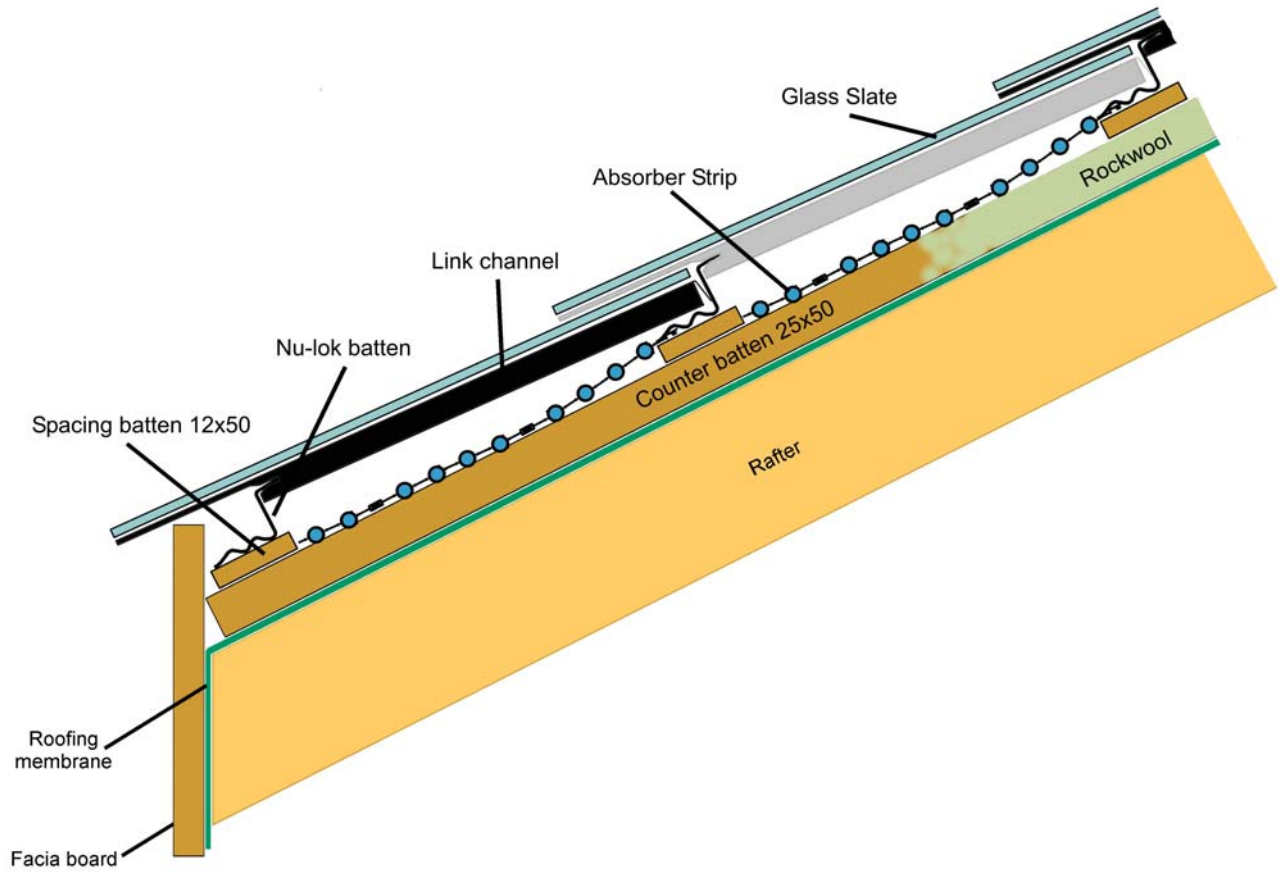
    When estimating materials using the website roof calculator, treat this strip area as a whole roof.

Specifications

SLATES	**Slate system**	**500 series**	**600 series**
	Material	4mm float glass, toughened to BS 6206	
	Standard slate size	500mm x 500mm	300 x 600mm
	Headlap	75-100mm	75-100mm
	Laying gauge	200-212mm	250-262mm
	Coverage	9.76/m^2	13.1/m^2
	Loading	25kg/m^2 (34kg/m^2 with absorbers & insul)	
	Minimum pitch	25° (30° sev.exp.)	23.5° (30° sev.exp.)
	Maximum pitch	70°	70°
	Battens	25 x 50mm +/-2mm, durable timber	
	Fixings	Stainless steel slate hooks and screws	
ABSORBERS	Material	Silicone	
	Expected life	25+ years	
	Width	212mm	262mm
	Water channels	6	8
	Channel diameter	8mm id / 12mm od	
	Fluid volume	300ml/m 1450ml/m^2	400ml/m 1550ml/m^2
	Max length one piece	25m (for 25-50m lengths contact Solex)	
	Loading	6kg/m^2, with fluid	
	Maximum fluid pressure	1 bar	
	Average annual output	410 kwh/m^2	
INSULATION	Type	25mm mineral fibre batt, 105kg/m^3	
	R value	0.037 Km^2/W	
	Loading	2.5kg/m^2	

Roof Installation – Nu-lok Range Solar Slates

The roof takes up a thickness of approx 80mm from the membrane upwards. The roof loading at 22kg/m^2 is similar to that for natural or artificial slates.



The roof is built up as follows:

1. **Rafters** – for complete eaves to ridge installation of solar slates the rafters should be of length (c x g)+50-f where c = number of courses, g = batten gauge between centres, and f = facia board thickness

2. **Membrane –** a breather membrane should be used, laid across any of:

    - Rafters, or
    - Rafters with insulation between, or
    - Insulation sarking boards, or
    - Timber sarking boards.

    The breather membrane MUST be laid correctly to form a waterproof layer which will drain water to the eaves without pooling. **In the event of any damage occurring to the absorber at any time, this breather membrane will ensure that no water enters the building.**

3. **Facia and eaves** – where the solar slates go right to the eaves the arrangement shown in the diagram above may be suitable, as long as care is taken over the fate of water running behind the facia. Alternatively other methods may be used, as long as the membrane is supported to prevent pooling. Note that plastic eaves carriers will melt in the heat created behind the glass slates.

4. **Counterbattens** – 25mm thick counterbattens must be used. These must go on top of the membrane, and start from under the second batten as shown.

5. **Insulation** – 25mm mineral fibre batts are cut to fit snugly between the counterbattens, over the whole roof except the far left and far right 'channels' between the counterbattens, which are left open to allow space for the absorber loops, manifolds and pipes.

The easiest way to cut the batts is to place one against a counterbatten, and cut down with a knife using the opposite counterbatten as a guide. Use a blunt tipped knife to avoid damaging the membrane.

Wetting of the insulation should be avoided if possible, although it will not be damaged by water. If exposed to the weather most water will drain out down the membrane, and the remainder will evaporate when the roof is watertight.

Note that the insulation supplied is the minimum recommended for the system. **Extra insulation, especially in the form of foam insulation boards over the rafters, will increase the efficiency of the system.**

6. **EPDM** – the left and right channels are covered with an EPDM membrane, which is stapled to the counterbattens and dressed neatly into the channel. This has three purposes – it protects the breather membrane from UV, it prevents the colour of the membrane from showing through the slates, and in the unlikely event of a leak from a manifold or pipe it offers added protection to the building. The EPDM must therefore be dressed over the eaves to allow run off.

The EPDM should also be used to cover any roof membrane, insulation, battens etc. which will show through the glass tiles if left uncovered.

7. **Spacing battens** – the metal Nu-lok battens used for this roof must be spaced away from the counterbattens by 10-12mm. This is achieved using thin laths nailed horizontally across the counterbattens at the Nu-lok batten interval (308 +/-2mm). These spacing battens must be positioned accurately, as the galvanised battens are fitted over them at this fixed spacing interval.

The spacing battens are stopped at the inside edge of the EPDM covered channel, and continued on the far side either horizontally or vertically (or thicker counterbattens used).

8. **Absorber strips, supply** – these are supplied on 25m rolls. For longer lengths joiner kits are supplied, consisting of short pipe segments and O clips.

   To find the length of absorber strip required, the length of the course where the absorber will lay is measured, and the *loop* factor is added for every end of course The roof calculator spreadsheet will output the length of absorber required. Alternatively, it may be necessary to work it out manually – the length of the course where the absorber will lay is measured, and the *loop* factor is added for every end of course – Nu-lok standard 310 gauge loop=200mm / Nu-lok narrow 210 gauge loop=130mm. The usual measuring points are the outer edges of the EPDM covered channels detailed above.

   Where the roof is sufficiently large, it is necessary to divide it into parallel absorber circuits, which should be as close to equal lengths as possible. For example a roof of 15 courses may be divided into three courses of 5, or a roof of 12 courses may be divided into circuits of 6, 4, 3 or exceptionally 2 courses depending on the overall length of the roof and therefore the length of absorber strip in each circuit.

   The Roof Calculator will give some guidance, although generally we recommend that each circuit does not exceed 40m in length, which equates to around 12.5m^2 of Nu-lok standard roofing or 8.5m^2 of Nu-lok narrow gauge roofing. There is no minimum length of circuits, although having many smaller circuits will result in more manifolds and connections.

9. **Absorber strips, installation** – when installing the rubber absorber, it is advisable to start at the top of the roof, so that there is less foot traffic on the installed rubber.

   Starting at the end where the top manifold is required, the absorber is unrolled along the spacing batten with the flange at the top. The flange is positioned over the bottom edge of the batten, and staple gunned to it at 300mm intervals. Standard staples may be used, as the absorber will be held in place later by the galvanised batten. Care must be taken that the staples do not damage the top tube.

   At the end of the course, in the channel where the EPDM has been positioned, the absorber is folded back on itself, still keeping the flange at the top. The individual tubes are then split away from each other so that each tube follows a natural curve down to the second course.

When splitting the tubes apart, great care must be taken not to damage the surface of any of the tubes. A pair of scissors (not a stanley knife) should be used. The point of the scissors is pushed through all the tear lines of the strip, and the tubes pulled apart in both directions as far as necessary. This should be done with care, as sometimes the split can start to run off toward a tube wall. If this happens, use the scissors again to re-start the tear.

The tubes should be arranged neatly so that there are no kinks which could disrupt the flow of water. The redundant top flange and centre strips may get in the way and can be removed at this point if desired.

The absorber is then run out along the next course as before.

In situations where the roof has already been battened, a problem occurs at the course ends where the absorber has to loop under the galvanised batten. In these cases the choice is to either thread the absorber under the batten, or to cut out a section of batten and re-fix it. If it is chosen to thread the absorber under the batten, then the section of split tubes must be arranged very carefully to prevent any of them kinking or squashing.

If it is necessary to join the strip, the ends are trimmed off square using a pair of scissors, and the 'wings' on the tubes cut back for about 50mm. A little silicone oil is sprayed on both the copper joining tubes and the insides of the manifold tubes. The joining tubes are inserted, and the O clips put on and crimped using the pliers supplied.

10. **Manifolds** – copper manifolds are used to terminate the absorber strips. The manifolds have 22mm open ends for the connection of the flow and return pipes. The manifolds are connected with silicone tubing, and O clips similar to those used on the absorbers. The manifolds are short enough to not be damaged by freezing water. Where any copper components are used on the roof there must be at least 50mm of supply pipe each side of them to allow for ice expansion.

The pipes and manifolds should lie in the EPDM covered channel, under the battens. The top of the inlet manifold or chain of manifolds is capped with a short length of silicone tube and a plug, as is the bottom of the outlet manifold or manifold chain.

Where the roof is sufficiently large to necessitate dividing it into parallel absorber circuits, all the inlet manifolds are piped in line up one side, and the outlets up the same or opposite side (depending on an even or odd number of courses. Sometimes it is necessary to return a pipe from an inlet or outlet across the roof, for instance when dividing a roof of 7

courses into 3 and 4 course circuits. Half manifolds are available for use in special circumstances.

The cold inlet pipe must flow in a generally upwards direction from the pump to the bottom of the lowest inlet manifold. The hot outlet pipe must connect to the top of the highest outlet manifold even if the outlet pipe subsequently runs down the roof. This must be done to ensure an even flow throughout the circuits, and to ensure that air is purged from the top circuits.

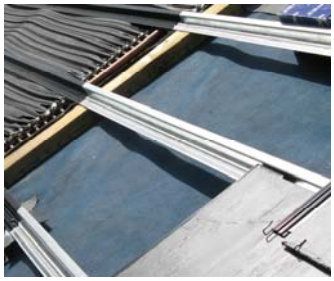
The inlet and outlet pipes should be taken into the loft or roof space for connecting onto the normal plumbing pipe used internally, ideally under a lap in the roofing membrane, which may be aided by the use of copper U pieces and elbows (supplied). Where it is not possible to pass the tubes under a lap, any penetration through the membrane should be made waterproof. Silicone rubber may be used and sticks well to the silicone tube, although its adhesion to the particular membrane being used should be checked.

The ends of the absorber strips are separated into individual tubes, and the wings trimmed off by about 50mm with scissors. Clips are put on the tubes and the tubes are connected to the manifolds using a silicone lubricant and crimp clips as detailed above.

11. **Pressure testing** – the system must be pressure tested with air to 2.0 bar. At this pressure any incorrectly made joints should leak or blow off. The system should be left under pressure during the installation of the slates, so that any absorber damage will immediately become evident. Note, air will diffuse through the silicone absorber, so the pressure will decrease over a period – e.g. overnight the pressure may drop from 2.0 to 1.5 bar.

12. **Sensor** – a roof temperature sensor is used to measure the temperature at the hottest point on the roof. It is fitted beneath the absorber strip, generally at a position at least 1 m from the top outlet manifold, near the centre of the absorber, and not close to any area obscured by conventional slates.

It should be positioned so that it will lie between two of the absorber tubes, and not next to any dead area of the strip. The sensor is secured to a counterbatten with a small fencing staple or similar, and covered with some silicone rubber. The absorber strip is laid in position over it so a good thermal and mechanical connection is formed.

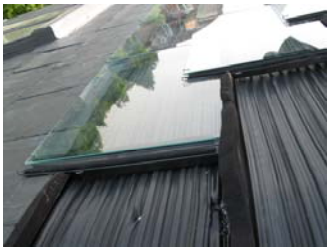


The wire is passed through the roofing membrane, ideally at an overlap. This high temperature wire with this sensor is 1.5m long and so will almost certainly need to be lengthened using conventional 0.75mm^2 two core lighting flex and a

connector block, which should both be located under the rockwool insulation or away from the absorber area to prevent heat damage. The sensor wires carry low voltage so an electrician is not required.

13. **Battens** – these are special galvanised battens supplied direct from Nu-lok. They are ideally fixed to the roof using a Paslode first-fix nailgun or similar, with hardened 60mm stainless steel nails, starting at the eaves. They are fixed in place so that the base of the batten holds the absorber flange against the spacing batten.

    The batten spacing is fixed at 308 +/-2mm, and the battens should be checked as they are installed to make sure that the link channels fit properly.



14. **Batten sealing strip** – a silicone rubber seal strip is supplied to fit over the Nu-lok battens to seal the gap between the glass slates against air movement and windblown moisture. This strip is fitted to the battens as glazing commences, starting with the first batten.

15. **Link channels** – a first row of link channels is installed on the first batten at the interval of the slate width. The link channels must be fairly central under the gaps between the slates so as to drain the water between the slates efficiently.

16. **Glass slates** – the glass solar slates are installed on these link channels. When installing the slates great care must be taken not to damage the absorbers.

    The glass stales are toughened and so cannot be cut. The roof calculator at www.solexenergy.co.uk can help with sizing a roof to an exact number of slates. The range of sizes supplied is:

Location	Nu-lok standard	Nu-lok narrow
Standard	400 x 400	300 x 600
Standard, optional	600 x 400	-
Verge	600 x 400	300 x 300
Verge, optional	300 x 400	-
Hips, valleys & cuts	Polycarb 1200 x 400	Polycarb 600 x 300
Horizontal coverage	402 / 602	602

The glass slates are simply inserted in the stainless hooks of the link channels and laid down. About 1-2mm should be left between them to allow for thermal expansion.

IF A PATCH OF ROOF IS BEING COVERED JUMP TO 21

17. **Eaves** – the eaves will overhang the first batten by 90mm

18. **Verge** – If the roof runs from one verge to another it is an advantage to design the roof to fit an exact number of slates, to the nearest half slate, using the slating interval given. The slates should be finished with a dry fit verge system, as recommended by Nu-lok. If running out to a second verge, which does not fit to the nearest ½ slate, polycarbonate slates will need to be cut to fit.

19. **Ridge** – the battens should be gauged out so that a full course is present at the ridge. Finish with a dry fix ridge.

20. **Hip** – polycarbonate slates are cut to size for use at a hip. Refer to the Nu-lok installation guide to see details of installation at hips. It is not recommended that a mitred finish is used with polycarbonate slates.

21. **Valley** – polycarbonate slates are used up the edge of a valley. Again, refer to the Nu-lok guide for more valleys details.

IF A WHOLE ROOF IS BEING COVERED SKIP 21 AND 22

22. **Slating a patch** – a patch of Nu-lok solar slates may be installed surrounded by compatible Nu-lok natural (300 x 400) or ceramic (400 x 400) slates. Due to the unique nature of the Nu-lok system, it is possible to achieve a straight vertical join between the different materials as the link channels make the joins weatherproof.

Use verge slates (600x400mm) to obtain the straight line with the glass slates, and cut the natural or ceramic slates to match.

23. **Slating a strip** – when installing the solar slates into a roof covered with an incompatible material – e.g. clay tiles – the easiest method is to install the solar slates as a strip. This method is the most suitable for retrofit situations, as the existing roof can be stripped off from the top down.

If the conventional tiles or slates are considerably thicker than the solar slates, the solar area will need to be raised. As a counterbatten is required anyway, this may go part of the way to achieving this extra height. Any extra height may be provided by thicker spacing battens, or thicker counterbattens with thicker insulation between them. The top of the insulation should still be flush with the tops of the counterbattens.

At the bottom of the strip the glass slates will lap over the existing material. Usually a strip of lead flashing 150-200mm

wide is required to obtain an adequate overlap, which is best installed before the first batten is fixed.

At the top the other roofing material may be lapped over the top edge of the glass slates, again with lead flashing attached to the batten above, to make the transition back to the other material. Alternatively, if the solar slates go right to the ridge, then finish with ridge tiles as detailed above.

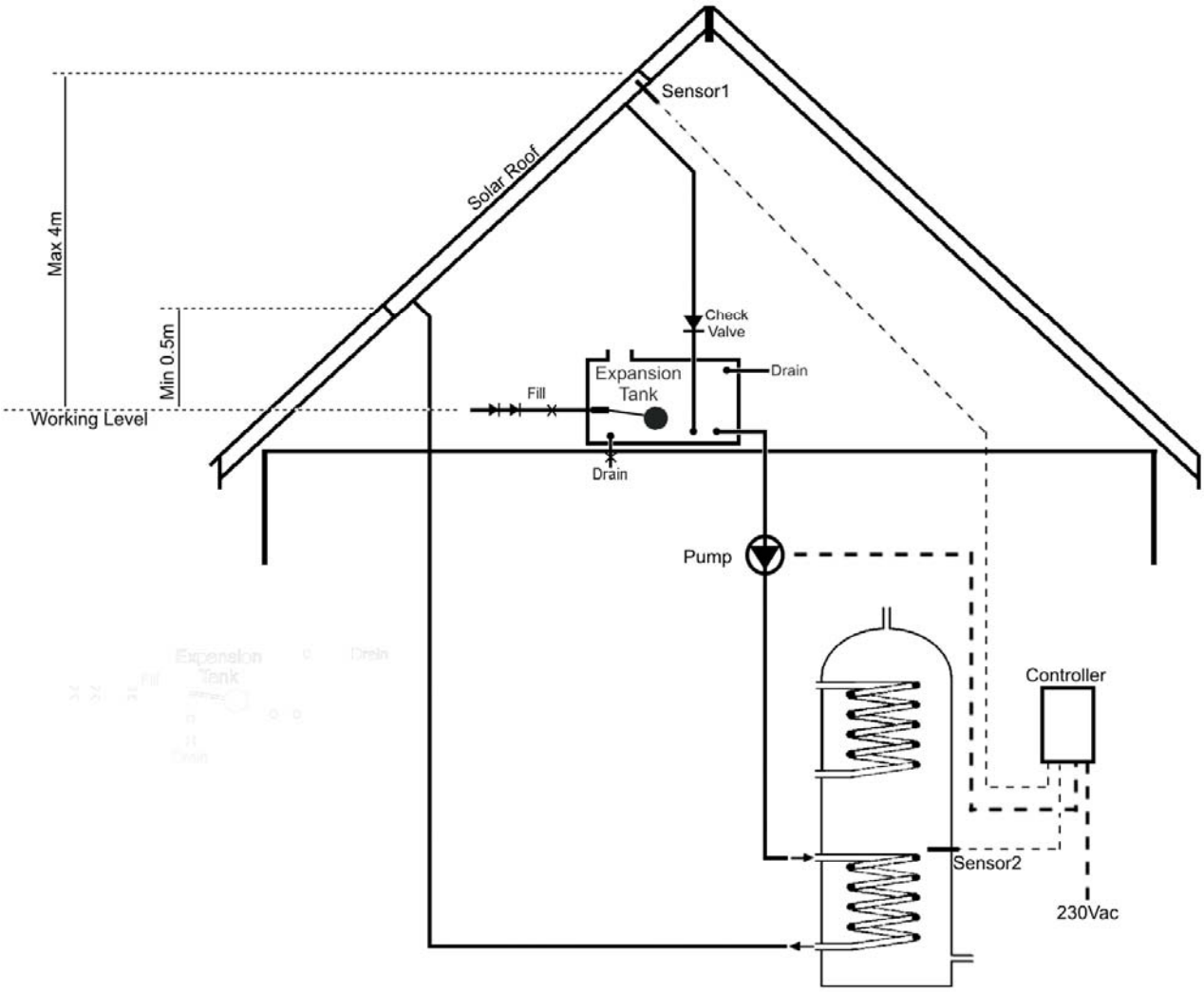
At the sides, it is easiest if the strip runs out to hips, valleys and/or verges, where it is finished as detailed above. Alternatively, if the strip meets the incompatible material at one or other side, a decision will need to be taken on-site as to the best interface method, which will usually involve some form of lead flashing.

When estimating materials using the website roof calculator, treat this strip area as a whole roof.

Specifications

SLATES	**Slate system**	**Nu-lok standard**	**Nu-lok narrow**
	Material	4mm float glass, toughened to BS 6206	
	Standard slate size	400mm x 400mm	600 x 300mm
	Headlap (fixed)	90mm	90mm
	Laying gauge (fixed)	308 +/-2mm	208 +/-2mm
	Coverage	8.09/m^2	8.00/m^2
	Loading	17kg/m^2 (25kg/m^2 with absorbers & insul)	
	Minimum pitch	22° (for 15°-22° contact Nu-lok)	
	Maximum pitch	90°	90°
	Battens	Galvanised steel	
	Link channels	Galvanised steel, stainless steel clips	
	Guarantee on fixings	50 years	
ABSORBERS	Material	Silicone	
	Expected life	25+ years	
	Width	212mm	262mm
	Water channels	10	6
	Channel diameter	8mm id / 12mm od	
	Fluid volume	500ml/m 1600ml/m^2	300ml/m 1450ml/m^2
	Max length one piece	25m (for 25-50m lengths contact Solex)	
	Loading	5.5kg/m^2, with fluid	
	Maximum fluid pressure	1 bar	
	Average annual output	410 kwh/m^2	
INSULATION	Type	25mm mineral fibre batt, 105kg/m^3	
	R value	0.037 Km^2/W	
	Loading	2.5kg/m^2	

Plumbing Installation – basic system



1. **Expansion tank** – this tank holds a reservoir of water for the system, and provides space for the water in the solar roof which may drop back into the tank in the event of an overheat situation when the roof exceeds about 90^{o}C, or in the event of a leak admitting air into the absorber, supply pipe or manifolds.

   The expansion tank is sized to the capacity of the system - the Roof Calculator spreadsheet may be used to calculate the tank size required exactly, however it is usually approximately as follows:

Roof area	L	W	H	Kg
up to 8m^2	350	270	370	35
up to 25m^2	600	300	450	80
up to 40m^2	1100	290	460	135
up to 70m^2	1100	290	620	185
up to 85m^2	920	420	630	220
up to 115m^2	1100	320	825	265
up to 200m^2	1250	360	1010	420

   The tank operates at ambient pressure, and the lid of the tank is vented to the air. The solar circuit flows through the tank, venting any air in the system as it passes.

The solar circuit connections are pre-installed into the tank on the short side. The float valve supplied must be installed through a hole 200mm above the tank base. This float valve is plumbed to mains water (via an isolating valve and double check valve, also supplied) to keep the tank topped up and to replace any water lost by vapour diffusion through the silicone absorber. An overflow is required (22mm tank fitting supplied) which must be installed right at the top of the tank, using copper pipe.

The tank should be located so that the working level line of the tank is a minimum of 500mm below the bottom of the solar roof, so that the water in the roof may easily flow back into the tank. (A label showing the working level is supplied with the tank.)

The tank should also be not more than 4m below the highest point of the solar roof area. This is so that the pump is able to pump the water efficiently to the top of the roof when priming the system. Systems where this measurement is exceeded will not prime. It is acceptable to use two pumps in series to increase the head in systems where this 4m is exceeded, or in systems where the pipe layout leads to airlocks. For future reliability, systems must always be able to self-prime without intervention.

2. **Pump** – a bronze type pump is used to move the water in the solar circuit. Cheaper standard central heating circulators *may* be used, but their life will be reduced by corrosion due to air diffusing into the water through the silicone absorber.

   The pump may be installed either in the flow or return pipework. It must be installed as per the manufacturer's instructions, which almost always means with the rotor axis horizontal and the electrical connection box at the top. Munsen ring pipe clips are supplied to aid mounting the pump if necessary. The pump electrical supply is taken from the controller. The pump should generally be set to maximum speed.

   One standard pump is sufficient to supply 30m^2 of roof. Where the roof exceeds this, two or more pumps operating in parallel may be used. This is more reliable and less expensive than using a single larger pump. A flow rate of at least 0.5 LPM/m^2 of solar roof needs to be achieved.

   Systems which will not prime due to the 4m height (above) being exceeded, or where the layout of the pipes is not ideal and leads to airlocks, may be fitted if necessary with two pumps in series (or 2x2 pumps for systems >30m^2).

3. **Plumbing pipe** – the solar circuit may be plumbed in any normal pipe system, including copper with soldered, compression or pushfit joints, or in flexible PEX pipe. The reason that any pipe material can be used is that the system is unable to pump water exceeding 100^{o}C. The use of polybutylene pipe is not recommended as the temperature rating for this type of pipe is usually lower than for PEX pipe. 22mm plastic PEX pipe will supply up to around 40m^2 of solar roof, depending on pipe runs.

   Normal pipe lagging may be used outside the roof area, and must be used where the pipes are subject to freezing. Within the hot zone, if lagging is used it must be the high temperature solar rated type.

4. **Roof inlet** – the transition to the silicone tube for the roof inlet is made by crimping the silicone tube onto either 22mm plastic pipe with a pipe insert, or onto metal pipe. If connecting to plastic, there should be a minimum of 500mm of silicone tube outside of the hot zone of the solar roof.

The silicone tube may be protected from vermin by sheathing it in an outer tube or conduit, and it should run in a generally upwards direction to the bottom of the roof.

The silicone pipe should connect to the bottom of the inlet manifold, or the bottom of the chain of inlet manifolds.

5. **Roof outlet** – this is connected to the top of the outlet manifold or manifold chain. As long as it starts from the top of the manifold(s), it may run downwards either within the solar roof, or within the roof space. Like the inlet pipe, it may be protected from vermin, and there must be a minimum of 500mm outside the hot zone before connecting to plastic pipe.

   Note: manual and auto air vents do not function in this type of system and must not be used

6. **Cylinder** – the hot flow from the solar roof should go via the expansion tank to the top of the dedicated solar coil in the hot water cylinder or thermal store.

   A sensor for the solar controller must be placed on or in the cylinder/store, at a height level with the top of the solar coil. See more on cylinders and thermal stores below.

7. **Check valve** – this is used to prevent convective circulation at night. It must go between the solar roof top outlet and the expansion tank. No other check valves should be fitted in the solar circuit.

8. **Pressure testing** – it is assumed that the system has been pressure tested with air to 1.5 bar during installation. Note that it is not sufficient to assume that leaks will be apparent when the system is filled with water, as leaks towards the top of the roof and in the outlet tube will draw in air and so may go unrecognised while still affecting system performance. Note, air will diffuse through the silicone absorber, so the pressure will decrease over time – e.g. overnight the it may drop from 1.5 to 1.0 bar.

9. **Filling and commissioning** – the expansion tank water supply is switched on and the float valve adjusted to fill the tank to the working level, which should be a depth of 150mm, and the label placed on the outside of the tank.

   The pump is set to its maximum setting, and is switched on using the Manual Mode setting on the controller (below), or by temporarily hard-wiring it if the controller isn't installed yet. Check that the pump valves are both on. Water should flow from the expansion tank, down to the cylinder, up through the roof and back to the expansion tank. Air will be expelled into the expansion tank.

   In the event that the circulation fails and the system does not fill completely, switch the pump off and on a couple of times to move trapped air. Some systems, especially with longer cylinder pipe routes may develop an air lock. This may be rectified by bleeding off near the cylinder, although it must be remembered that if the system will not self-prime, then there may be occasions in the future when the circulation airlocks.

   The water level will rise slightly when the pump is switched off. Any significant and sustained rise above the working level indicates a leak admitting air into the roof or roof supply pipes, and should be investigated. Otherwise, the only time the water level should rise significantly is in an overheat situation, when steam in the absorber will

replace the water, allowing the water to drop back into the tank.

10. **Antifreeze –** the roof absorber, manifolds and silicone supply pipes are resistant to freeze damage, so generally just water is used in the system. However, if the solar flow and return pipes are of a type that may be damaged by freezing (e.g. copper), and they are used outside the thermal envelope of the building (e.g. in a cold loftspace), then antifreeze should be used. In such cases we recommend the propylene glycol type of antifreeze, which should be used at a concentration of around 30% glycol to 70% water (depending on local conditions).

Plumbing Installation – solar hot water systems

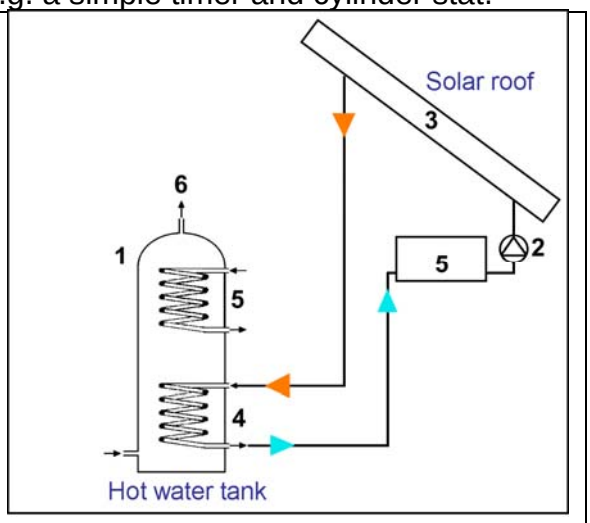
Hot water systems store solar heated water in a hot water cylinder. The cylinder itself may be either the **pressurised/unvented/mains pressure** type, or it may be the less expensive **vented** type fed from a cold water tank in the loft. This choice does not affect the operation of the solar heating.

Whatever arrangement is used, provision must be made to kill off legionella bacteria (which can grow in temperatures between 20°C and 45°C) for example by heating the water up to 60°C at least once a week. One method to achieve this is by means of an immersion heater with a suitable controller unit – e.g. a simple timer and cylinder stat.

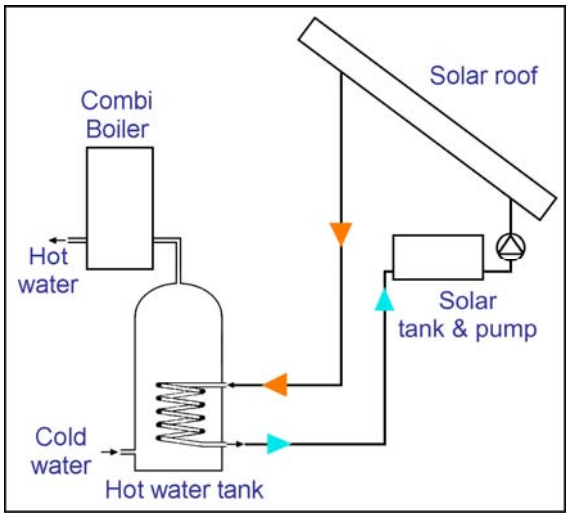
Systems using a new solar cylinder:

System boiler – a new twin coil cylinder is fitted to replace the existing single coil one, with the solar collector heating the whole cylinder from the bottom, and the boiler topping up the temperature in the upper section when required.

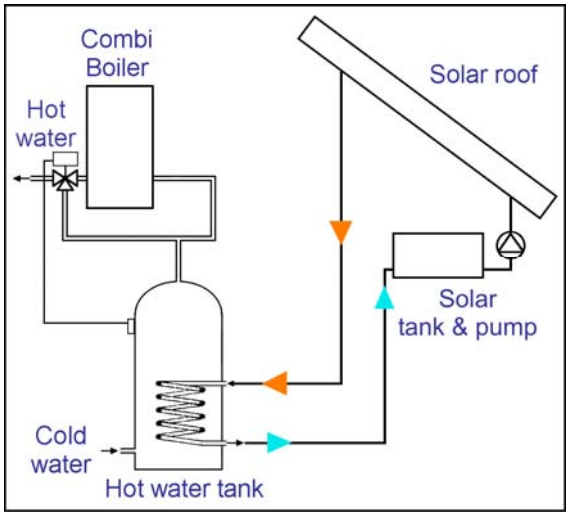
1) Twin coil cylinder, 200 - 300 litres capacity
2) Solar pump circulates water from tank
3) Solar roof, heats water
4) Cylinder coil heats cylinder from bottom
5) Boiler coil tops up if necessary
6) Hot water out



Combination boiler – a single coil cylinder is installed with the solar connected to its coil. If the boiler is 'solar compatible' and thus accepts pre-heated hot water, then the output from the cylinder may be fed through the boiler to the taps. A cylinder of 120 - 150 litres is usually used for this purpose. [2x combi diagrams]

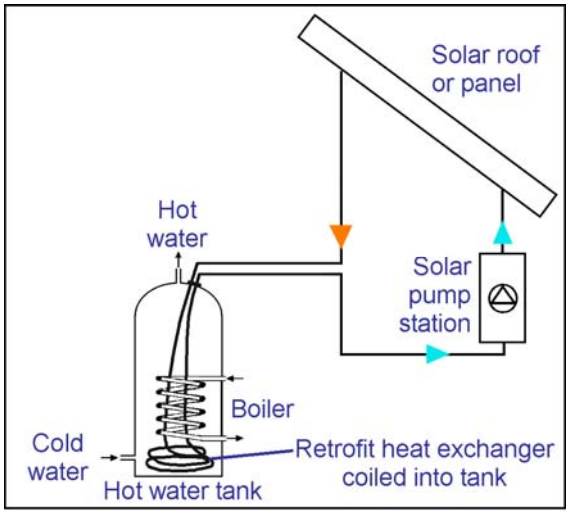


Where a combination boiler is not 'solar compatible', then a three port valve is used to select water from either the boiler or from the cylinder. The three port valve is controlled by a tank thermostat at the top of the cylinder, which is set to the minimum acceptable temperature for hot water use.



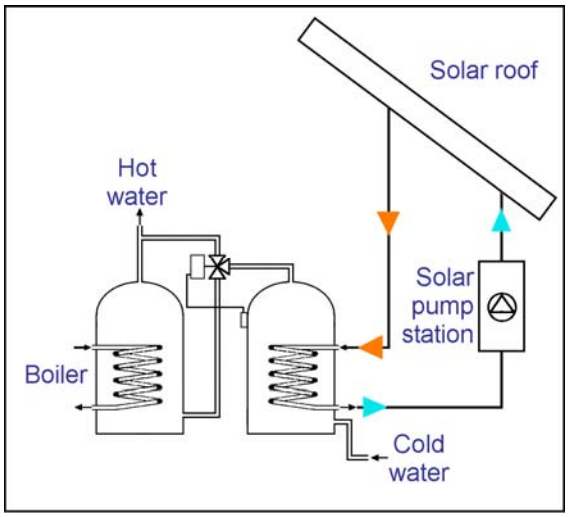
Systems retaining the existing cylinder

Retro-fit coil – a retro-fit heat exchange coil is fitted into the existing hot water cylinder by removing the immersion heater. No change to existing plumbing is required. The existing cylinder should be of adequate size, and in good condition. See the retro-fit coil section below.

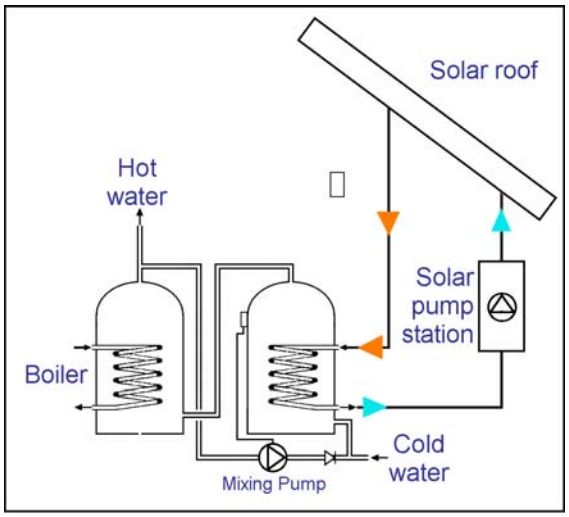


Second cylinder – a new cylinder is installed, with the solar roof indirectly heating the new cylinder and another heat source indirectly heating the existing cylinder. The cold feed is to the solar preheat cylinder, and hot water is taken from the second cylinder.

A three way valve is used to select water from the solar cylinder or the existing cylinder, controlled by a cylinder stat, set to the lowest acceptable hot water temperature.



Second cylinder with pump mixing – as an alternative to valve control, a pump may be used to mix the cylinders, controlled by a cylinder stat. This has the advantage that both cylinders can be heated by the solar input.



Plumbing Installation – combined space and water heating

There are several methods of using solar heat for both water and space heating:

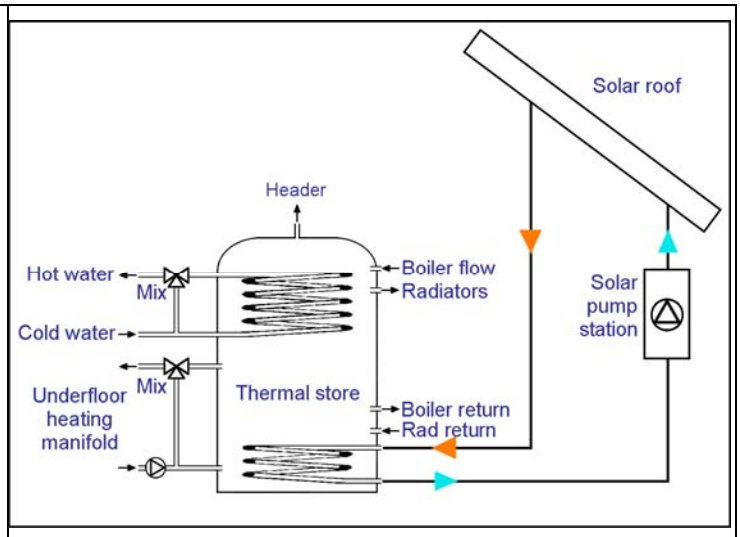
The simplest way of combining solar water and space heating is to use a thermal store as the central element of the system. All heat inputs are put into this, and all heat requirements, including hot water, taken from it. See the section on installing thermal stores for more information.

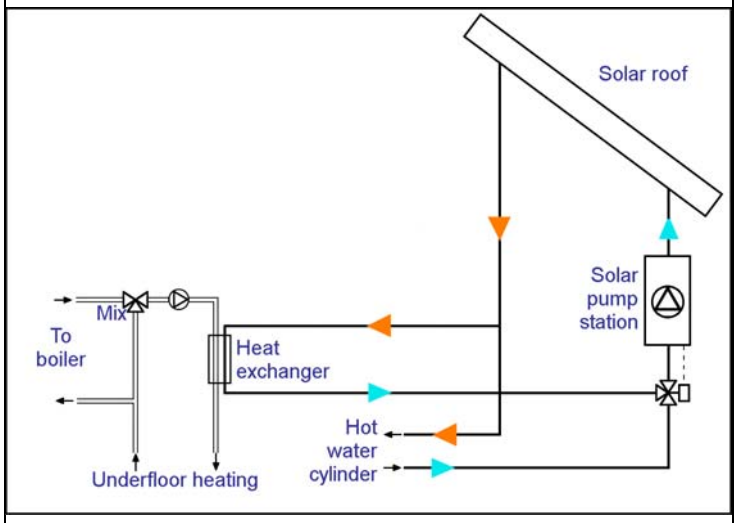
An alternative to this is to use a flat plate heat exchanger to put the solar heat into a pumped radiator or underfloor heating circuit. Underfloor heating is the delivery method of choice, as it can operate effectively in some cases with supply temperatures down to 25°C. With this method of ustilising solar heating, it should be noted that the only heat storage available is where the underfloor heating is installed in a concrete floor slab or screed with a reasonable thermal mass.

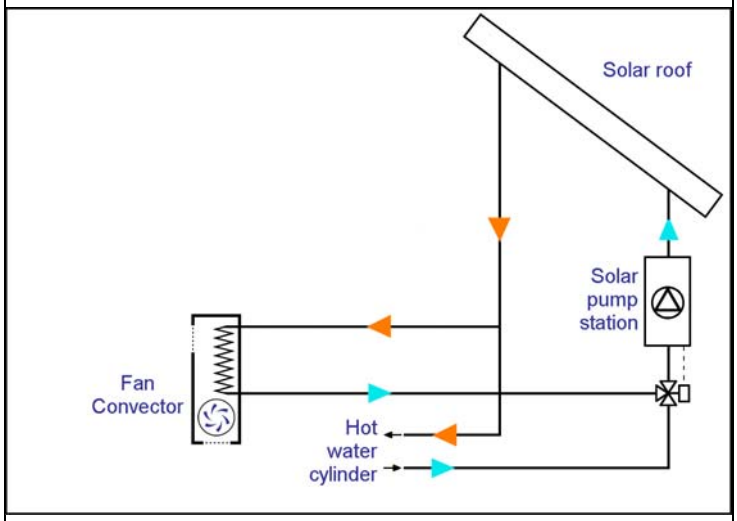
A hot water cylinder is also required, installed as for the hot water systems shown above. A three port valve on the outlet of the solar roof selects the hot water cylinder coil or the flat plate heat exchanger as necessary, under the control of the solar controller.

More on installing flat plate heat exchangers may be found below.

A third method is to use a convector radiator to distribute the solar heat. This uses a three port valve to switch the solar heat, as in the system above.





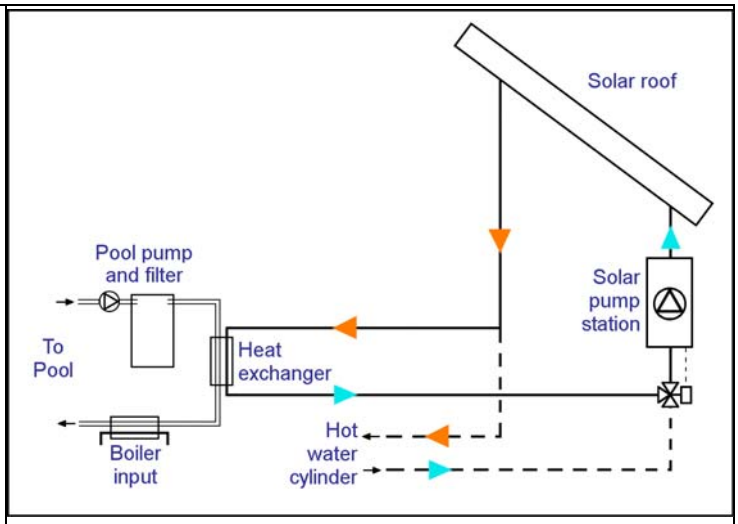


Plumbing Installation – pool heating systems

Where a solar roof heats a pool, spa or hot tub, the heat usually is input via a pool heat exchanger. This is fitted after the pool pump and filter, and before the boiler supplied heat exchanger, if fitted.

Where hot water is also required from the system, the solar flow may be diverted with a three port valve as for the space heating systems above.

The heat exchangers supplied by us are cylindrical, with pool water connections via 1½" female connections on the ends. One end has a pocket for a thermosensor, and this should go at the pool inlet end – the cold end. Connections for the solar flow are via ¾" female connections on the top. Note that the heat exchangers are resistant to chlorine in the water, as long as water chemistry (pH) is correct. Incorrect chemistry will cause corrosion of the exchanger.



If the system will be dedicated to pool heating, with no hot water or other heating requirement, then it is possible to pass pool water directly through the roof, subject to using a suitable pump, and stainless steel absorber manifolds.

Plumbing Installation – thermal stores

Solar stores do the same job as a hot water cylinder, but they are generally larger, ranging upwards of 300 litres. The major difference is that the body of water in the store is heating system water. This has several benefits:

- Many inputs and outputs can be connected without having to use separate coils for each.
- There is little risk of legionella in the hot water circuit, as only the contents of the coil is heated at any one time.

Location – these stores are usually located on the ground floor, as they are heavy when full. They stand about 150mm off the floor on 3 metal feet. Typically they are located in a garage or plant room, although for best efficiency the store should be located within the thermally insulated envelope of the building so that any inevitable heat losses from the store and pipework are not lost.

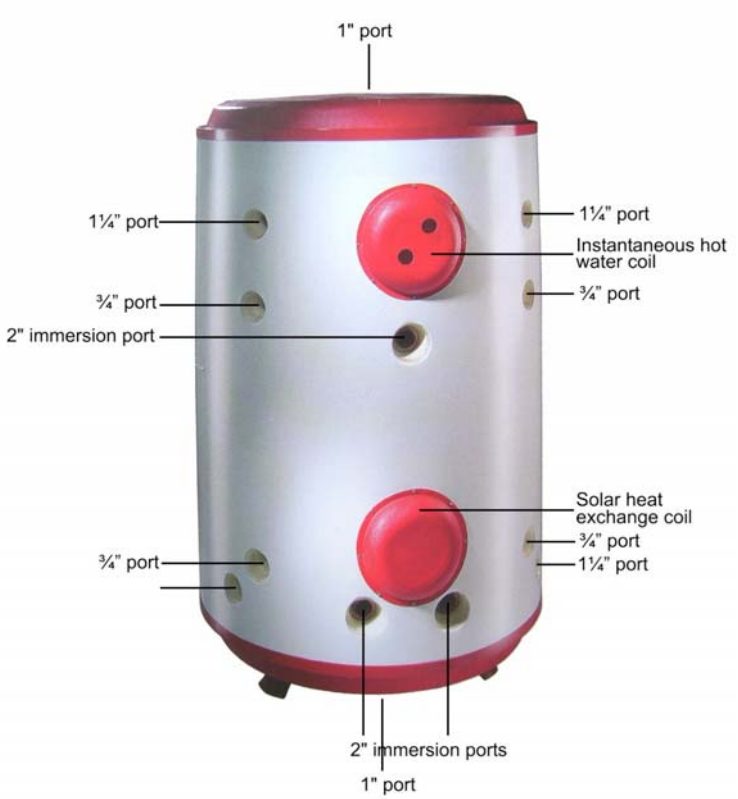
Thermal stores are large so provision must be made for physically getting them to the intended location. They are optionally available with detachable insulation reducing the

diameter by 200mm. To remove the insulation, loosen the small bolts holding the external metal covering and remove it. The insulation can then be easily removed.

System design – the pressure rating of these stores is 1.5 bar (optionally 3.0 bar), and they are generally installed with a feed and expansion tank. Where a boiler, heat pump or other plant feed directly into the store, then the minimum pressure rating of all the components must be looked at.

When used with a solar input, care must be taken that the thermal stratification, of cold at the bottom and hot at the top, is not disrupted. This enables the solar system to input heat to the coolest part of the store, and thus extract the maximum potential from the solar roof.

Heat exchange coils – there are two finned copper heat exchange coils rated at 10 bar. The connections are ¾ male for the standard sized exchangers. Generally these are arranged:



- **Upper coil** – this is used to heat hot water as required. It is recommended that a suitably sized mixing valve is used on the hot water output. The mixing valve increases the system efficiency, as it means a) the store can hold more heat without the risk of scalding, and b) water can be distributed at a lower temperature so reducing heat losses.

- **Lower coil** – this is generally used for the solar input.

The heat exchangers are bolted into the stores with 20x M10 bolts. When installing a coil into a store the weight of the coil hanging on the flange makes this a difficult operation. It is facilitated by the use of a couple of lengths of M10 studding as guide rods.

If necessary, the bottom solar coil may be bent down so that it heats right to the bottom of the store, increasing the system efficiency. This is also necessary on some stores where the ¾“ port for the sensor is located below the level of the solar coil hatch.

Store connections – all the ports feed directly into the body of water in the store. These ports are all female threads, and are:

- **Central top 1”** – this is usually used for the pipe to the F&E tank.

- **Central bottom 1”** – this is used as a drain point.

- **Top left & right 1¼”, bottom left & right 1¼”** – these are usually used for the main boiler, radiator and underfloor heating connections. They have guide pipes to the extreme top and extreme bottom of the store, respectively.

- **2" ports** – these are designed for the installation of (European size) immersion heaters, although they may be bushed down to accept other connections. A note on immersions heaters: the units which we supply have 3x elements and so may be wired for single or three phase. The thermostat will control single of three phase, and is a dual unit having an overheat cutout. This is reset using the small black button, which must be pressed hard to reset.

- **¾" ports (4)** – these may be used for thermosensor pockets, or for any miscellaneous inlets or outlets.

Unused ports are blanked with iron plugs.

Solar heating connections – when used for combined solar water and space heating systems, the connections should be as follows:

- Boiler flow to top 1¼" port, boiler return to mid point up the store. The boiler circuit needs a pump, with both the pump and boiler being switched on by a stat on the thermal store, ideally linked to a time switch which restricts boiler input during the peak solar heating hours of 10am to 3 pm.

- Radiator supply from top 1¼" port, radiator return to bottom 1¼" port. The radiator circuit needs its own pump, switched by a room stat and timeswitch.

- Underfloor heating, Option 1 – dedicated supply from thermal store, supply from mid point on store, return to lower 1¼" port. This is the most efficient option, especially when using solar heat. Option 2 – connect the UFH manifold(s) across the radiator supply circuit. With this method the solar cannot input so much heat to the UFH.

- Hot water from upper heat exchanger

- Solar heat into lower heat exchanger

- Wood burning stove, if present, into top 1¼" port, return from bottom 1¼" port. The system may use gravity feed as long as the pipe runs, height difference etc is suitable for this. Where a pumped system is used, a mixing manifold is available which includes a pump for the stove circuit. This manifold only inputs water above 80^{o}C into the store, which ensures that the stratification of the store is maintained – cold at the bottom and hot at the top.

Biomass connections – when used with a biomass boiler, without solar, the connections should be as follows:

- Boiler flow to top 1¼" port, boiler return to bottom 1¼" port. The boiler circuit will usually require a pump.

- Heating supply (radiators and underfloor heating) from top 1¼" port, return to bottom 1¼" port. The heating circuit needs its own pump, switched by a room stat and timeswitch.

- Hot water from upper heat exchanger

- The lower heat exchange coil is not required.

Specifications

	Litres	Diameter	Height	Weight empty, 1.5 bar, kg	Weight full, 1.5 bar, kg
ROUND	300	710	2050	130	430
	500	800	2050	155	655
	750	950	2050	200	950
	1000	1050	2100	230	1230
	1500	1250	2150	280	1780
	2000	1400	2200	330	2330
	2500	1500	2250	360	2860
	3000	1600	2300	400	3400
	4000	1800	2350	480	4480
	5000	2000	2500	600	5600
RETROFIT	500	810	1550	130	630
	700	810	2050	160	860
		Depth/Width			
OVAL	1400	810/1630	1660	420	1820
	2000	810/2060	1840	500	2500
	2400	810/2060	2160	560	2960

- Option – any of the round stores can be supplied with removable insulation. This reduces their diameter by 200mm.
- Option – all standard stores can be supplied with 2, 1 or no heat exchange coils.
- Option – all stores can be supplied with 3 bar rating.
- Option – more than two heat exchange coils to order

Plumbing Installation – retrofit cylinder coils

The kit contains a screw in header, and 4m or 6m of DN12 flexible stainless steel pipe with fittings.

Installation

When fitting, the pipe is first formed into a coil of the required size and shape to fit the cylinder. This coil must be small enough in diameter to clear any existing coil if present. Note the narrow bottom loop to enable insertion through the 2¼“ immersion port. When the coil is being used for a solar input, it should be made to fit as low down in the cylinder as possible.

After forming the basic shape, the ends of the tube are if necessary cut to the same length with a normal pipe cutter.

Next fit the backnuts to the tube, and fit the split circlip washers to the first corrugations. Then screw the backnuts onto the header unit, without the washers, and tighten them up to flatten the end of the tube. Remove the backnuts, fit the ½” fibre washers to the backnuts, the 2¼ “ washer to the header, and refit the stainless coil to the header, tightening up the nuts fairly firmly.

The completed retro-fit coil can now be screwed into the cylinder through the immersion port. A standard UK 8 sided immersion spanner will fit the header.

The inlet and outlet pipes are then fitted to the header with standard 22mm solder or compression fittings, or 22mm push fit subject to the maximum temperature of the circuit.

Header material	Brass	
Pipe material	Stainless steel, DN12	
Header fitting	2¼ " male thread	
Inlet/outlet	22mm	
Pipe length	4m	6m
Surface area	0.31m^2	0.47m^2

Plumbing Installation – multiple solar roofs

Same orientation – where two or more solar roofs are installed with the same orientation, they may be fed from the same solar pump, subject to sizing the pump to the total roof area. It may be necessary to install isolating valves to each roof to enable priming and air flushing of the system. It may also be necessary to use valves to balance the flow through the roofs.

Where the roofs are substantially different in size and/or height, then it may be advisable to install a pump for each roof. Both or all the pumps can be controlled together.

Different orientations – where two or more differently orientated roofs are installed, then each must have its own pump, individually controlled by an upgraded controller. Each roof must also have a check valve located between the hot roof outlet and the cylinder/heat exchanger.

Electrical Installation

See the system diagram on page 25 for the basic electrical layout.

Solar Controllers

- **Deltasol A and AX** – controls 1 roof and 1 store (no display). One relay output.
- **Deltasol BS3** – controls 1 roof and 1 store. Has thermostat function for backup heating. 2 relay outputs.
- **Deltasol BS4** – controls 1 roof and 1 store, with variable pump speed. Has thermostat function. 2 relay outputs.
- **Deltasol BS Plus** – controls 1 roof and 2 stores, or 2 roofs and 1 store, or 1 roof 1 store and thermostat function. Variable pump speed. 2 relay outputs.
- **Deltasol ES** – controls up to 2 roofs and 2 stores with backup heating and other functions. 5 relay outputs and one floating relay. See the manual for more details.
- **Deltasol E** – more advanced than the ES. See the manual for more details.
- **Deltasol M** – more advanced than the E. See the manual for more details.

All controller manuals are available at www.solexenergy.co.uk

Solar controller wiring, 230vac – the solar controller should be fitted somewhere where it can be seen and operated by the building occupiers. An airing cupboard is often suitable. It must have a 230vac supply via a fused spur (3A), or it can be fitted with a 13A plug. The incoming mains is wired as shown behind the controller front panel.

Solar pump, 230vac – the controller is connected to the pump with 3 core cable or flex. Where the wiring is fixed adjacent to the solar plumbing, then it should be high temperature rated.

The pump is connected to relay R1. On BS4 and more advanced controllers this is a solid state relay, which can control the pump speed.

Where several pumps are fitted for roofs orientated in the same direction, then they may all be connected together to R1.

Where two pumps are fitted for differently orientated roofs, then the pump for Roof1 is controlled by R1, and the pump for Roof2 is controlled by R2.

Solar controller & pump, 12v – a 12v controller is available. This may be supplied using a solar PV panel with a wattage in the range 30-50w. A 12v pump designed for use with PV panels is available, which may be supplied either directly from the panel without using a controller, or using a controller and with a small lead acid battery and charge controller to stabilise the supply. The advantage of using the controller is more accurate control of the pump, and therefore higher system efficiency.

3 port valve – this controls the solar flow on systems with more than one store or heat exchanger, and directs it to the required location. It is wired to relay R2 on BS Plus controllers and R4 on higher spec controllers. Note any heat input device, e.g. cylinder coil, pool heat exchanger, flat plate heat exchanger etc is termed a store in relation to controller wiring and system layouts. See the controller manuals for specific system layouts and connections.

On standard mid position valves with five wires, the controller relay output is connected to the White and Grey wires together. The other connections are Blue to neutral and Green to earth – Orange is not used. The valve therefore switches from one position to the other, as there is no facility on the controllers to use it in the mid position state. These valves typically only come with 1m of flex, so a junction box will usually be required.

Sensors – the roof sensor has a black silicone sheathed lead and is mounted on the roof as detailed in the roof section above. If there is any likelihood of lightening induced surges, then a protection device is available.

The cylinder sensor has a light grey sheathed lead, 2.5m long. It should be located in a sensor pocket, or touching the cylinder wall, at a height level with the top of the solar coil. Where this is not possible it is acceptable to position it anywhere down to the height of the centre of the coil. If it is placed too low, the system could overheat the cylinder. If it is placed too high the system will function with reduced efficiency.

A sensor for a flat plate heat exchanger should be mounted with a good thermal connection to the cold inlet pipe on the non-solar side of the exchanger. It may be mounted with a jubilee clip or similar, and it is recommended that it is lagged so as to get an accurate reading. A standard cylinder sensor may be used, or special pipe sensors are available with a flange and clip for fitting.

The sensor for a pool heat exchanger should be located in the exchanger sensor pocket, which should be on the cold pool water inlet side of the exchanger. If no pocket is available, it may be mounted on the pipe as above.

The sensor wires only carry low voltage, and may be extended if necessary using conventional 0.75mm^2 two core lighting flex and connector blocks.

Sensor faults – sensor line break or short is indicated on the controller (see below). The correct sensor values are: 1000ohms@0^{o}C / 1078@20^{o}C / 1155@40^{o}C / 1232@60^{o}C

Systems inputting heat into a pumped circuit

Where the solar roof is required to input heat into a **pumped circuit**, for example a heat exchanger in a pumped pool water circuit, or a flat plate exchanger in a heating circuit, then generally a mains 2 way relay (SPDT) will need to be used to force on the **pumped circuit** circulation pump. This must be wired so as to switch the pool or heating circulation pump from external (e.g. boiler) control, to ON (live, from the same circuit), when the solar roof is inputting heat.

Where the there is only one store, e.g. dedicated pool systems, then the relay should switch on with the solar pump. To do this the relay coil should be connected to the solar pump relay R1 on the controller. In addition where the controller varies the pump speed (BS4 and above) then the minimum pump speed on the controller must be set at 100%. Failure to set the minimum pump speed may result in a buzzing and malfunctioning relay.

Where there are two roof pumps controlled separately, then two relays must be used with the contacts in series, so that either R1 or R2 can switch the **pumped circuit** pump on independently, without reverse feeding the external control.

Where there are two stores, and the **pumped circuit** is the one switched in by a motorised valve, then the relay can be operated by the power to the valve.

Where there are two stores, and the **pumped circuit** is the default store with the motorised valve at rest, then two relays will need to be used as above, with one operated by the solar pump R1, and one operated by power to the valve, but so when the valve is powered it puts the pumped circuit pump back under external control.

Where there are two **pumped circuits**, then the circulation pump of each must be individually forced on when the solar pump is running, AND that circuit is switched in.

Controller programming

These controllers have three buttons, LEFT and RIGHT to scroll through functions, and a middle SET button to change a function. To set a parameter, scroll through LEFT or RIGHT to find the correct place, press SET, use LEFT and RIGHT to adjust the value, and then press SET.

Controller display

Faults	Indicated by flashing symbols on the display
Readings	888.8 = sensor line break -88.8 = sensor line short
Controller LED	Red=standby / Green=pump operating / Flashing=malfunction

First parameters:

COL, COL1, COL2	Collector temperature(s)
TST, TST1, TST2	Store temperature(s)
n%, n1%, n2%	Pump speed
h P	System operating hours
Faults	Indicated by flashing symbols on the display

To move beyond these keep RIGHT pressed for 2 seconds. Factory default settings should be used, except for the following:

Parameter	Meaning	Set to
Arr	Program for different system layouts	As required
DT O	Switch on temperature difference	4.5°C
DT F	Switch off temperature difference	2.5°C
S MX	Maximum store temperature (Hot water should be 55-65°C)	As required
PRIO	Store priority. Set to hot water store on 2 store systems	1,2 etc
nMN	Minimum pump speed. Default setting 30%	As required
HND1, HND2	Manual mode R1,R2. Use to test system, then set to auto	Auto

For other parameters refer to the instruction book supplied or at www.solexenergy.co.uk, or www.resol.de.

Maintenance

Generally, very little maintenance is required.

Roof maintenance

- **Cleaning** – these roofs do not need routine cleaning. There has been no history of moss or lichen build up on these roofs, due to the natural weathering, and the temperatures the glazing reaches in the sun.
- **Breakages** – glass roof slates are very robust, being stronger than natural slates. They are edge sensitive however, and a lucky strike by a large stone or similar hard object could break one. When broken they disintegrate into small fragments like automobile glass
- **Removal & replacement, Solar Slates** – if broken, clean out the remaining fragments, and bend the slate clip down. If intact, bend the clip down and ease the slate out downwards. Push in a new slate, watching that it does not catch on the adjacent screws. Silicone oil lubricant may be used to ease installation. Bend the clip back with care to hold it in place.
- **Removal & replacement, Nu-lok Slates** – if broken, clean out the remaining fragments. If intact, push the slate up by about 5mm, push the wire clips to the sides and drop the slate out. To replace, move the stainless wire clips to the sides and push up a new slate. Silicone oil lubricant may be used to ease installation.

System maintenance – annual

- **Water level** – check that this is at the working level, and adjust the float valve if necessary. In normal operation the level should only be higher than the working level if all the stores are up to their maximum temperatures, and the roof temperature exceeds 95^{o}C. If it rises under other conditions suspect a leak.

- **System function** – check that the system is functioning and circulating. This is best done by feeling the pipe temperatures, taking account of the prevailing conditions. If necessary use the manual mode of the controller to force on pumps/valves etc and feel the pipe temperatures to check circulation.

- **Pump** – if the pump is hot, but the pipes some distance from it are not, then either the pump may have failed, or there may be a system airlock. First, remove the screw from the end of the pump and check/restart rotation. If this is operating, the fault is probably an airlock.

- **Motorised valves** – check these operate by using the controller manual mode to force them on/off.

- **Integrity of roof** – any problem with a leak in the roof or supply/return pipes is usually evidenced by frequent air in the system exiting into the expansion tank. To check, turn the pump off and observe the tank level. Any sustained rise indicates a leak. The tank level should not rise, even after 12 hours or more (with the exception of overheat conditions when the roof temperature exceeds about 90^{o}C.)

- **Controller and sensors** – any fault state is shown by a flashing LED, and a spanner symbol on the display. See the controller section for more details.